ACID-BASE BIFUNCTIONALIZED HYDROTALCITE CATALYST FOR BIODIESEL PRODUCTION FROM WASTE COOKING OIL USING ULTRASOUND-ASSISTED REACTOR SYSTEM

by

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LIST OF ABBREVIATIONS

a.u.	Arbitrary unit
Al	Aluminum
Al^{3+}	Aluminum ion
AlO	Aluminum oxide
A^{n-}	Anion
ANOVA	Analysis of variance
ASTM	American Society for Testing and Materials
BET	Brunauer Emmett Teller
C	Carbon
CCD	Central composite design
CO_2	Carbon dioxide
CO_3^{2-}	Carbonate ion
Cu	Copper
CuO	Copper oxide
DF	Dilution factor
DOE	Design of experiment
EDX	Energy dispersive X-ray
EN	European standard
FAME	Fatty acid methyl ester
FFA	Free fatty acid
FID	Flame ionization detector
FRU	Fructose
FTIR	Fourier Transformed Infrared Spectrometry

GC	Gas chromatography
GLU	Glucose
H^+	Hydrogen ion
HFU	High frequency ultrasound
HT	Hydrotalcite
KBr	Potassium bromide
LDH	Layered double hydroxide
LFU	Low frequency ultrasound
M^{2+}	Divalent metal ion
M^{3+}	Trivalent metal ion
MeOH	Methanol
Mg	Magnesium
Mg^{2+}	Magnesium ion
$MgAl_2O_4$	Spinel
MgAlO	Metal oxides
MgO	Magnesium oxide (periclase)
MPOB	Malaysian palm oil board
N_2	Nitrogen
Na	Sodium
NH_3-TPD	Ammonia temperature programmed desorption
Ni	Nickel
Ni^{2+}	Nickel ion
NiO	Nickel oxide
OH^-	Hydroxyl ion
rpm	Rotation per minute

RSM	Response surface methodology
SAC	Saccharose
SEM	Scanning electron microscope
TGA-DTG	Thermal gravimetric analyzer-derivative thermal gravimetric
WTP	Willingness to pay
XRD	X-ray diffraction
Zn	Zinc
ZnO	Zinc oxide

LIST OF SYMBOLS

Symbol	Descriptions	Unit
A	Arrhenius factor (pre-exponential factor)	
C_{TG}	Concentration of triglycerides in oil phase	
C_{TGo}	Highest initial concentration of triglycerides	
CV	Coefficient of variance	
E_a	Activation energy	kJ/mol
F	Fisher F-test	
k	Reaction rate constant	dm^3/mol.h
M/O	Methanol to oil ratio	
n	Number of mol	mol
N_A	Initial amount of reactant	mol
P/P_o	Relative pressure	
R	Gas constant	J/mol.K
R^2	Coefficient of determination	
R_{sample}	Relative area ratio of FAME sample	
$R_{standard}$	Relative area ratio of FAME standard	
r_{TG}	Consumption rate of triglycerides	mol/dm^3.h
T	Temperature	^oC/K
t	Reaction time	h
V	Total volume	dm^3
V_P	Pore volume	
W_{FAME}	Weight of FAME sample	g
W_{oil}	Weight of oil used	g

X_i, X_j	Variables corresponding to factors	
Y	Response determined by model	
α	Distance from the center in central composite design	
ε	Error	
θ	Theta	
λ_i	The linear effect coefficient	
λ_{ii}	The linear effect coefficient	
λij	The cross-product coefficient	
λ_o	Constant coefficient	
$\rho_{FAME.st}$	Mass concentration of FAME standard	g/l
v_{sample}	Volume of product sample	l